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Docket No. 47769-00009  
RL.P50940US

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants: Björn EHRSTEDT et al. ) Group Art Unit: not assigned  
Serial No.: (NOT YET ASSIGNED) ) Examiner: not assigned  
Filed: (Herewith) )

For: PACKET TRANSMISSION IN A UMTS NETWORK

jc932 U.S. PTO  
09/678717  
10/04/00

Commissioner for Patents  
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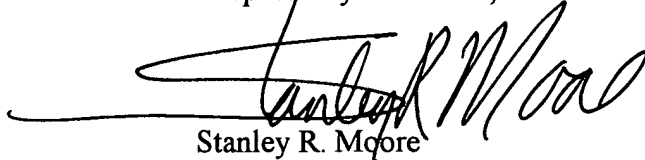
Signature Marty Balko

Dear Sir:

CLAIM OF PRIORITY UNDER 35 U.S.C. § 119

Under the provisions of 35 U.S.C. 119 Applicant hereby claims the priority of British patent application no. GB9924764.5 filed on October 19, 1999, which is mentioned in the declaration of the above-identified application. A certified copy of the priority document is filed herewith.

Respectfully submitted,

  
Stanley R. Moore  
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INVESTOR IN PEOPLE

## CERTIFIED COPY OF PRIORITY DOCUMENT

The Patent Office  
Concept House  
Cardiff Road  
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South Wales  
NP10 8QQ



I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation and Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein together with the Statement of inventorship and of right to grant of a Patent (Form 7/77), which was subsequently filed.

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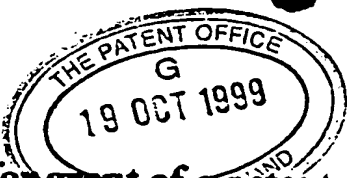
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16



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200CT99 E485417-1 003312  
 P01/T100 0.00 - 9924764.5

The Patent Office

Cardiff Road  
 Newport  
 Gwent NP9 1RH

1. Your reference

RL.P50940GB

2. Patent application number

(The Patent Office will fill in this part)

**9924764.5**

19 OCT 1999

3. Full name, address and postcode of the or of each applicant (underline all surnames)

Telefonaktiebolaget LM Ericsson  
 SE-12625  
 Stockholm  
 Sweden

Patents ADP number (if you know it)

If the applicant is a corporate body, give the country/state of its incorporation

**763730003**  
 SWEDEN

4. Title of the invention

Packet Transmission In A UMTS Network

5. Name of your agent (if you have one)

Marks & Clerk

"Address for service" in the United Kingdom to which all correspondence should be sent (including the postcode)

Marks & Clerk  
 4220 Nash Court  
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 Oxford  
 OX4 2RU

Patents ADP number (if you know it)

727 1125 001 ✓

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and (if you know it) the or each application number

Country

Priority application number  
 (if you know it)

Date of filing  
 (day / month / year)

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application

Date of filing  
 (day / month / year)

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? (Answer Yes if:

- a) any applicant named in part 3 is not an inventor, or
  - b) there is an inventor who is not named as an applicant, or
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Description 8

Claim(s) 2

Abstract 1

Drawing(s) 3

10. If you are also filing any of the following, state how many against each item.

Priority documents

Translations of priority documents (none)

Statement of inventorship and right to grant of a patent (Patents Form 7/77) (none)

Request for preliminary examination and search (Patents Form 9/77) 1

Request for substantive examination (Patents Form 10/77) (none)

Any other documents (please specify) (none)

11. I/we request the grant of a patent on the basis of this application.

Signature *Marks & Clerk* Date 19 Oct, 1999  
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12. Name and daytime telephone number of person to contact in the United Kingdom  
Dr. Robert Lind 01865 397900

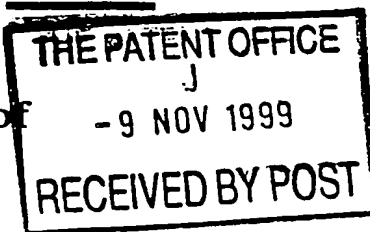
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**Statement of inventorship and of  
right to grant of a patent**



The Patent Office

Cardiff Road  
Newport  
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1. Your reference

RL.P50940GB

2. Patent application number  
(If you know it)

9924764.5

3. Full name of the or of each applicant

Telefonaktiebolaget LM Ericsson

4. Title of the invention

PACKET TRANSMISSION IN A UMTS NETWORK

5. State how the applicant(s) derived the right  
from the inventor(s) to be granted a patent

By virtue of employment of the inventors

6. How many, if any, additional Patents Forms  
7/77 are attached to this form?  
(see note (c))

10

7.

I/We believe that the person(s) named over the page (and on  
any extra copies of this form) is/are the inventor(s) of the invention  
which the above patent application relates to.

Signature *Marks & Clerk* Date  
Marks & Clerk 8 November 1999

8. Name and daytime telephone number of  
person to contact in the United Kingdom

Dr. Robert Lind 01865 397900

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Enter the full names, addresses and postcodes of the inventors in the boxes and underline the surnames

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DUPLICATE

1

**PACKET TRANSMISSION IN A UMTS NETWORK**Field of the Invention

- 5 The present invention relates to packet transmission in a Universal Mobile Telecommunications System (UMTS) network and more particularly to the scheduling of packets for transmission over the air interface of a UMTS network.

Background to the Invention

10

- The European Telecommunications Standardisation Institute (ETSI) is currently in the process of standardising a new set of protocols for mobile telecommunications systems. The set of protocols is known collectively as the Universal Mobile Telecommunications System (UMTS). Figure 1 illustrates schematically a UMTS network 1 which  
15 comprises a core network 2 and a UMTS Terrestrial Radio Access Network (UTRAN) 3. The UTRAN 3 comprises a number of Radio Network Controllers (RNCs) 4, each of which is coupled to a set of neighbouring Base Transceiver Stations (BTSs) 5. Each BTSs 5 is responsible for a given geographical cell and the controlling RNC 4 is responsible for routing user and signalling data between that BTS 5 and the core  
20 network 2. All of the RNCs are coupled to one another. A general outline of the UTRAN 3 is given in Technical Specification TS 25.401 V2.0.0 (1999-09) of the 3rd Generation Partnership Project, ETSI.

- User and signalling data may be carried between an RNC and a mobile terminal  
25 (referred to in UTRAN as User Equipment (UE)) using Radio Access Bearers (RABs). Typically, a mobile terminal is allocated one or more Radio Access Bearers (RABs) each of which is capable of carrying a flow of user or signalling data. RABs are mapped onto respective logical channels. At the Media Access Control (MAC) layer, a set of logical channels is mapped in turn onto a transport channel, of which there are  
30 two types: a "common" transport channel which is shared by different mobile terminals and a "dedicated" transport channel which is allocated to a single mobile terminal. One type of common channel is a Forward Access CHannel (FACH). A basic characteristic of a FACH is that it is possible to send one or more fixed size packets per transmission

time interval (10, 20, 40, or 80 ms). However, in any one given time interval all of the transmitted packets must be of the same length. Several transport channels (e.g. FACHs) are in turn mapped at the physical layer onto a Secondary Common Control Physical CHannel (S-CCPCH) for transmission over the air interface between a BTS  
5 and a mobile terminal.

When a mobile terminal registers with an RNC, via a BTS, that RNC acts at least initially as both the serving and controlling RNC for the mobile terminal. The RNC both controls the air interface radio resources and terminates the layer 3 intelligence  
10 (Radio Resource Control (RRC) protocol), routing data associated with the mobile terminal directly to and from the core network. Figure 2 illustrates the protocol model for the FACH transport channel when the serving and controlling RNCs are coincident and where Uu indicates the interface between UTRAN and the mobile terminal (UE), and Iub indicates the interface between the RNC and a NodeB (where NodeB is a  
15 generalisation of a BTS). It will be appreciated that the MAC (MAC-c) entity in the RNC transfers MAC-c Packet Data Units (PDUs) to the peer MAC-c entity at the mobile terminal, using the services of the FACH Frame Protocol (FACH FP) entity between the RNC and the NodeB. The FACH FP entity adds header information to the MAC-c PDUs to form FACH FP PDUs which are transported to the NodeB over an  
20 AAL2 (or other transport mechanism) connection. An interworking function at the NodeB interworks the FACH frame received by the FACH FP entity into the PHY entity.

Consider now the situation which arises when a mobile terminal leaves the area covered  
25 by a RNC with which the terminal is registered, and enters the area covered by a second RNC. Under the UTRAN protocols, the RRC remains terminated at the first RNC whilst the terminal takes advantage of a cell and common transport channel of the second RNC. Thus, the first RNC remains as the serving RNC with a connection to the core network whilst the second RNC becomes the controlling RNC. The controlling  
30 RNC is in control of the NodeB where the mobile terminal is located and in particular of the logical resources (transport channels) at that NodeB. In this scenario the controlling RNC is referred to as a "drift" RNC (the controlling RNC will also be acting as a serving RNC for mobile terminals registered with that RNC). The protocol model

for the FACH transport channel when the serving and controlling RNCs are separate is illustrated in Figure 3. It will be noted that a new interface Iur is exposed between the serving and the controlling RNCs. An Iur FACH FP is used to interwork the Common MAC (MAC-c) at the controlling RNC with the Dedicated MAC (MAC-d) at the  
5 serving RNC.

In both of the scenarios illustrated in Figures 2 and 3, an important task of the MAC-c entity is the scheduling of packets (MAC PDUs) for transmission over the air interface. If it were the case that all packets received by the MAC-c entity were of equal priority  
10 (and of the same size), then scheduling would be a simple matter of queuing the received packets and sending them on a first come first served basis. However, UMTS defines a framework in which different Quality of Services (QoS) may be assigned to different RABs. Packets corresponding to a RAB which has been allocated a high QoS should be transmitted over the air interface as a high priority whilst packets  
15 corresponding to a RAB which has been allocated a low QoS should be transmitted over the air interface as a lower priority. Priorities are determined at the MAC entity (MAC-c or MAC-d) on the basis of RAB parameters.

UMTS deals with the question of priority by providing at the controlling RNC a set of  
20 queues for each FACH. The queues are associated with respective priority levels. An algorithm is defined for selecting packets from the queues in such a way that packets in the higher priority queues are (on average) dealt with more quickly than packets in the lower priority queues. The nature of this algorithm is complicated by the fact that the FACHs which are sent on the same physical channel are not independent of one  
25 another. More particularly, a set of Transport Format Combinations (TFCs) is defined for each S-CCPCH, where each TFC comprises a transmission time interval, a packet size, and a total transmission size (indicating the number of packets in the transmission) for each FACH. The algorithm must select for the FACHs a TFC which matches one of those present in the TFC set.

30

Statement of the Invention

A possible problem arises where the controlling RNC is a drift RNC. This is because the MAC-d entity exists at the serving RNC, and it is the MAC-d entity which allocates priorities to packets, based upon the packet scheduling algorithm used by that RNC (when acting as a controlling RNC). The allocated priorities and packet sizes may not  
5 however conform with the packet scheduling algorithm used by the drift RNC. Packets received at the drift RNC from the serving RNC may not therefore be dealt with with an appropriate priority.

According to a first aspect of the present invention there is provided a method of  
10 scheduling packets for transmission over the air interface of a UMTS Terrestrial Radio Access Network (UTRAN) in the case where a pair of Radio Network Controllers (RNCs) are acting as separate serving and controlling RNCs for a mobile terminal, the method comprising:

sending from the controlling RNC to the serving RNC, allocated scheduling  
15 priorities together with packet sizes accepted for transmission with those priorities on transport channels by the controlling RNC; and

subsequently sending from the serving RNC to the controlling RNC packets of sizes accepted by the serving RNC together with respective allocated priorities.

20 Embodiments of the present invention ensure that a serving RNC allocates a packet size to a given priority which is acceptable to the controlling RNC, avoiding a mis-match between priority and packet size at the controlling RNC.

Preferably, the information sent from the controlling RNC to the serving RNC  
25 comprises a set of allocated priorities, each having one or more associated package sizes, for each of a plurality of logical channel types to be mapped onto a transport channel at the controlling RNC. More preferably, said information comprises such a set for each logical channel type to be mapped onto a transport channel at the controlling RNC.

30

It will be appreciated that the packet sizes which may be allocated to priorities may change, depending for example upon the load in a cell serving the mobile terminal or in the event that the mobile terminal moves into another cell controlled by the same



controlling RNC. Preferably therefore, a new list of packet sizes and priorities may be sent from the controlling RNC to the serving RNC under appropriate circumstances.

Preferably, the list of priorities and packet sizes is received at the serving RNC by the  
5 RRC entity. More preferably, the list is sent in a RNSAP message.

Preferably, a packet received at the controlling RNC is placed in a queue for transmission on a Forward Access CHannel (FACH), the queue corresponding to the priority level attached to the packet and to the size of the packet. The FACH is mapped  
10 onto a S-CCPCH at a Base Transceiver Station (BTS) or other corresponding node of the UTRAN. More preferably, the packets for transmission on the FACH are associated with either a Dedicated Control CHannel (DCCH) or to a Dedicated traffic CHannel (DTCH).

15 Preferably, each FACH is arranged to carry only one size of packets. This need not be the case however, and it may be that the packet size which can be carried by a given FACH varies from one transmission time interval to another.

A given priority may be allocated one or more packet sizes, defined in the list sent to  
20 the serving RNC.

According to a second aspect of the present invention there is provided a UMTS Terrestrial Radio Access Network (UTRAN) comprising a plurality of interconnected Radio Network Controllers (RNCs), wherein, when a mobile terminal has separate  
25 serving and controlling RNCs, the controlling RNC is arranged to send to the serving RNC, packet sizes accepted for transmission by the controlling RNC together with allocated relative priorities which may be attached to those accepted packets sizes, and the serving RNC is arranged to send to the controlling RNC data packets having sizes accepted by the serving RNC, together with respective allocated priorities.

30

#### Brief Description of the Drawings

Figure 1 illustrates schematically a UMTS network comprising a core network and a UTRAN;

Figure 2 illustrates a protocol model for a FACH transport channel when serving and  
5 controlling RNCs of the UTRAN of Figure 1 are coincident;

Figure 3 illustrates a protocol model for a FACH transport channel when serving and  
controlling RNCs of the UTRAN of Figure 1 are separate;

10 Figure 4 is a flow diagram illustrating a method of scheduling packets for transmission  
at a controlling RNC of the UTRAN of Figure 1.

#### Detailed Description of a Preferred Embodiment

15 The general structure of a UMTS network has been described above with reference to  
the schematic drawing of Figure 1. Protocol models for the FACH transport channel  
have also been described with reference to Figures 2 and 3 for the cases where the  
serving RNC and controlling RNC are both coincident and separate.

20 Considering the scenario illustrated in Figure 3, where a mobile terminal communicates  
with the core network of a UMTS system via separate serving and controlling (or drift)  
RNCs within the UTRAN, signalling and user data packets destined for the mobile  
terminal are received at the MAC-d entity of the serving RNC from the core network  
and are "mapped" onto logical channels, namely a Dedicated Control CHannel (DCCH)  
25 and a Dedicated traffic CHannel (DTCH). The MAC-d entity constructs MAC Service  
Data Units (SDUs) comprising a payload section containing logical channel data and a  
MAC header containing amongst other things a logical channel identifier.

The MAC-d entity passes the MAC SDUs to the FACH Frame Protocol (FP) entity.  
30 This entity adds a further FACH FP header to each MAC SDU, the FACH FP header  
including a priority level which has been allocated to the MAC SDU by a Radio  
Resource Control (RRC) entity. The RRC is notified of available priority levels,  
together with an identification of one or more accepted packet sizes for each priority

level, following the entry of a mobile terminal into the coverage area of the drift RNC. At that time, the controlling RNC issues a resource request to the drift RNC. More particularly, this request is a Common Transport Channel Request having the following form:

5

<i>Information element</i>	<i>Reference</i>	<i>Type</i>
Message type		M
Transaction ID		M
D-RNTI		M
Cell Id		M
Transport Bearer Request Indicator		M

where "M" indicates a mandatory field.

The drift RNC responds to receipt of the resource request by returning a response message (RNSAP), referred to as a Common Transport Channel Response, having the following form:

10

<i>Information element</i>	<i>Reference</i>	<i>Type</i>
Message type		M
Transaction ID		M
Common Transport Channel Information		
Common Transport Channel Priority Indicator		M
Common Transport Channel Initial Window size		M
Common Transport Channel Data Frame Size		
Data Frame Size		M
Transport Layer Address		O
Binding Identity		O
DL Channelisation Code		O

where again "M" indicates a mandatory field and "O" indicates an optional field. The RNSAP message contains a list of priorities accepted by the drift RNC, together with an identification of one or more accepted packet sizes for each priority. Such a list may be sent for each logical channel type although this need not be the case. The list of priorities is sent to each MAC-d entity connected to the MAC-c entity in the drift RNC. For example, the list may define that for SDUs having a priority 1, a MAC-d entity may use packet sizes of 80 or 320 bits. Where a priority/packet size list is provided for each logical channel type, the RNSAP message used to carry the list contains a logical channel type identifier directly after the Common Transport Channel information.

15

20

The priority/packet size list is typically sent from the drift RNC to the serving RNC when a mobile terminal first enters the coverage area of a new RNC whilst being previously registered with another RNC. An updated list may be exchanged between  
5 the drift RNC and the serving RNC when the terminal moves between cells of the new RNC to reflect the priorities available at the new BTS. It will also be appreciated that an updated list may be sent even when a mobile terminal remains within a given cell, due to changing circumstances such as changes in the levels of traffic in the cell or a reconfiguration of the radio network resources.

10

The RRC examines the received RNSAP message and carries out any necessary reconfiguration of the MAC-d entity. A reconfiguration of the Radio Link Control (RLC) entity (which resides above the MAC-d layer in the serving RNC and is responsible for the segmentation of data) additionally takes place.

15

The FACH FP packets are sent to a peer FACH FP entity at the drift RNC over an AAL2 connection. The peer entity decapsulates the MAC-d SDU and identifies the priority contained in the FRAME FP header. The SDU and priority are passed to the MAC-c entity at the controlling RNC. The MAC-c layer is responsible for scheduling  
20 SDUs for transmission on the FACHs. More particularly, each SDU is placed in a queue corresponding to its priority and size (if there are 16 priority levels there will be 16 queue sets for each FACH, with the number of queues in each set depending upon the number of packet sizes accepted for the associated priority). As described above, SDUs are selected from the queues for a given FACH in accordance with some  
25 predefined algorithm (so as to satisfy the Transport Format Combination requirements of the physical channel).

It will be appreciated by those of skill in the art that various modifications may be made to the above described embodiments without departing from the scope of the present  
30 invention. For example, the above embodiment requires the sending of a priority/packet size list in an RNSAP message. In an alternative embodiment, a RNC may issue a "global" list covering all mobile terminals using that RNC as a drift RNC.

## Claims

1. A method of scheduling packets for transmission over the air interface of a UMTS Terrestrial Radio Access Network (UTRAN) in the case where a pair of Radio  
5 Network Controllers (RNCs) are acting as separate serving and controlling RNCs for a mobile terminal, the method comprising:
  - sending from the controlling RNC to the serving RNC, allocated scheduling priorities together with packet sizes accepted for transmission with those priorities by the controlling RNC; and
  - 10 subsequently sending from the serving RNC to the controlling RNC packets of sizes accepted by the serving RNC together with respective allocated priorities.
2. A method according to claim 1, wherein the information sent from the controlling RNC to the serving RNC comprises a set of allocated priorities, each having  
15 one or more associated package sizes, for each of a plurality of logical channel types to be mapped onto a transport channel at the controlling RNC.
3. A method according to claim 2, wherein said information comprises such a set for each logical channel type to be mapped onto a transport channel at the controlling  
20 RNC.
4. A method according to any one of the preceding claims, wherein a new list of packet sizes and priorities is sent from the controlling RNC to the serving RNC to replace an old list, following a change in circumstances at the controlling RNC.  
25
5. A method according to any one of the preceding claims, wherein the list of priorities and packet sizes is received at the serving RNC by a MAC-d entity.
6. A method according to claim 5, wherein the list is sent to the serving RNC in a  
30 RNSAP message.
7. A method according to any one of the preceding claims, wherein a packet received at the controlling RNC is placed in a queue for transmission on a Forward

Access CHannel (FACH), the queue corresponding to the priority level attached to the packet and to the size of the packet.

8. A UMTS Terrestrial Radio Access Network (UTRAN) comprising a plurality of  
5 interconnected Radio Network Controllers (RNCs), wherein, when a mobile terminal  
has separate serving and controlling RNCs, the controlling RNC is arranged to send to  
the serving RNC, packet sizes accepted for transmission by the controlling RNC  
together with allocated relative priorities which may be attached to those accepted  
packets sizes, and the serving RNC is arranged to send to the controlling RNC data  
10 packets having sizes accepted by the serving RNC, together with respective allocated  
priorities.

**ABSTRACT****PACKET TRANSMISSION IN A UMTS NETWORK**

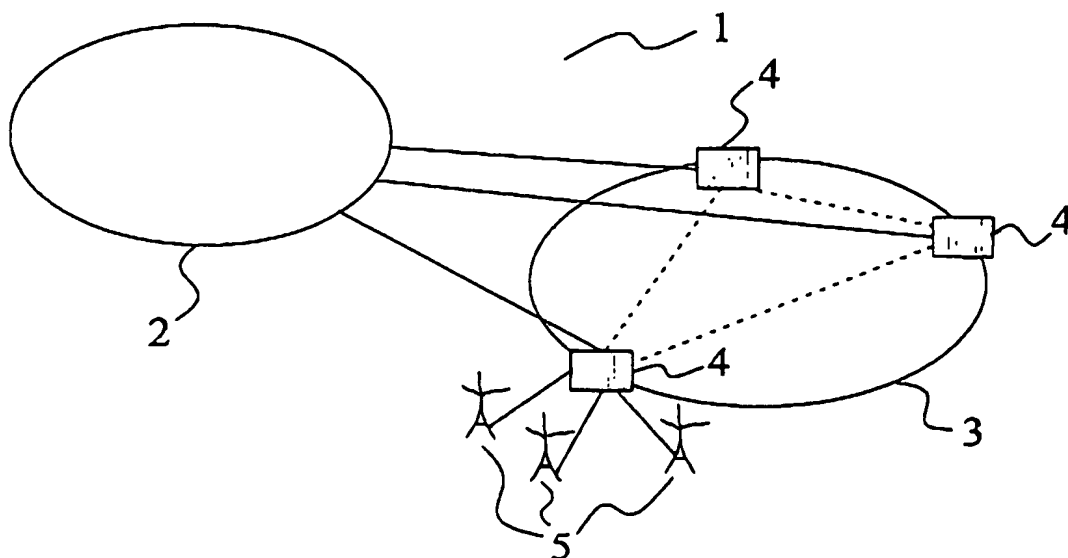
A method of scheduling packets for transmission over the air interface of a UMTS  
5 Terrestrial Radio Access Network (UTRAN) in the case where a pair of Radio Network  
Controllers (RNCs) are acting as separate serving and controlling (drift) RNCs for a  
mobile terminal. The method comprises sending from the controlling RNC to the  
serving RNC, allocated scheduling priorities together with packet sizes accepted for  
transmission with those priorities by the controlling RNC. Subsequently the serving  
10 RNC send to the controlling RNC, packets of sizes accepted by the serving RNC  
together with respective allocated priorities.

Figure 3

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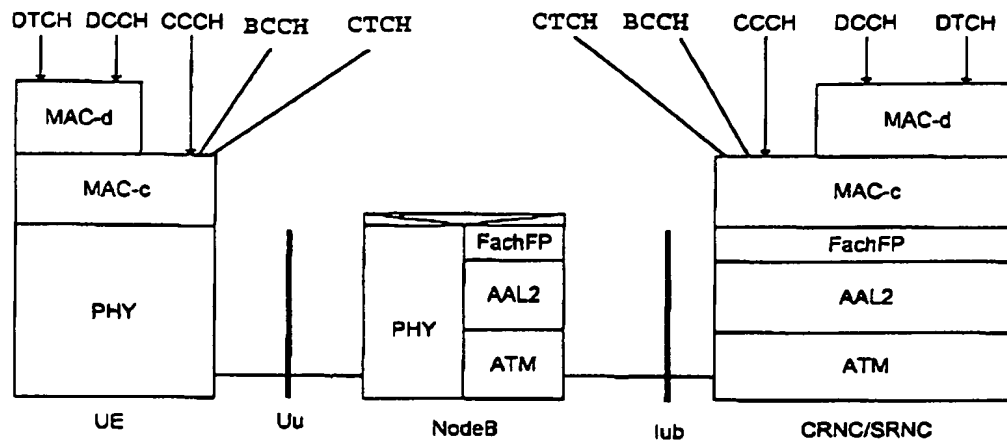
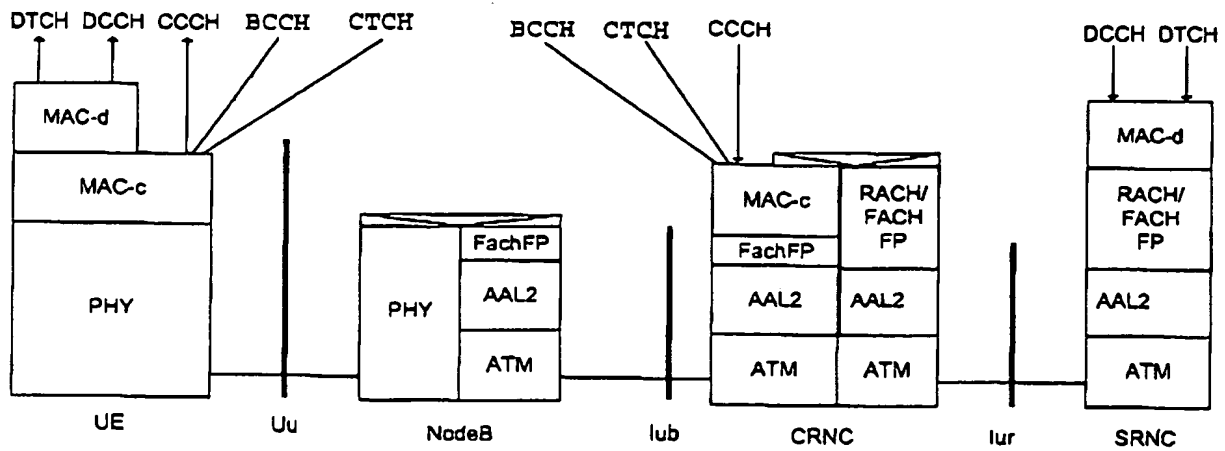


1/3

Figure 1

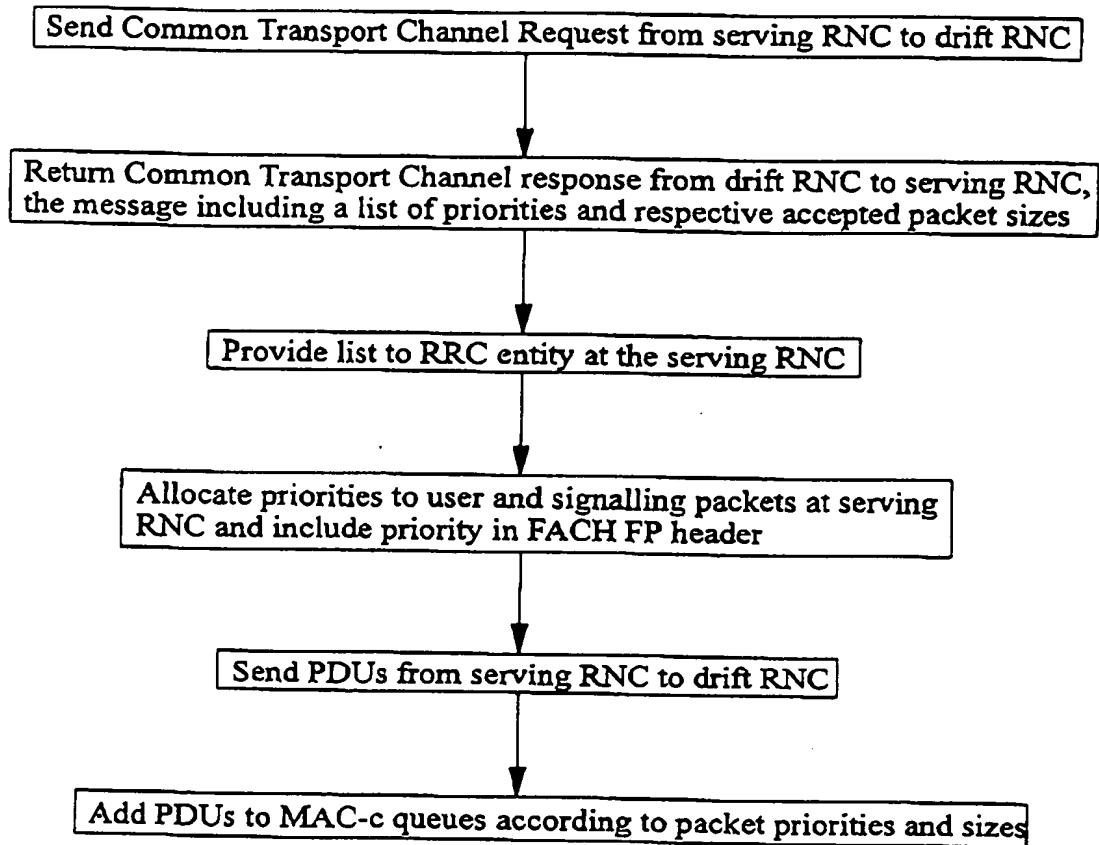
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2/3

Figure 2Figure 3

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3/3

Figure 4

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